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Organisational learning as an antecedent of technology transfer and new product development

A study of manufacturing firms in Malaysia

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Received January 2010
Revised May 2010
Accepted July 2010

Abstract

Purpose – The purpose of this paper is to examine the influence of organisational learning (comprising absorptive capacity, nature and type of alliances and learning environment) through strategic technology alliances on technology transfer and new product development. The paper is based on a larger research on alliances in the Malaysian manufacturing industry.

Design/methodology/approach – The antecedents and outcomes of organisational learning were tested using structural equation modelling, based on data collected from 335 organisations through an online survey questionnaire.

Findings – The findings depict that absorptive capacity, nature and type of alliances and learning environment significantly affect technology transfer in Malaysian manufacturers, but not necessarily new product development simultaneously. Nevertheless, the results establish technology transfer as an effective means for building innovative capabilities in developing new products. This is imperative for attaining Malaysia's current goal in improving the manufacturing industry and becoming an industrialised nation by the year 2020.

Research limitations/implications – The findings advocate further deliberations for manufacturers in Malaysia in shaping their strategies and learning objectives when embarking on collaborative relations, as these can result in technological competencies and ultimately the capacity to develop new innovative products.

Practical implications – The paper offers useful insights for manufacturers when forming technology alliances; and facilitate decisions by current practitioners in managing collaborations. The paper also informs Malaysian Government institutions in developing mechanisms, economic policy strategies and business support services for enhancing the economic and commercial viability of Malaysian manufacturing activities and products.

Originality/value – The value of this paper lies in discerning the current capabilities and strategies of manufacturing firms in developing nations in order to remain competitive.

Keywords Strategic alliances, Product development, Malaysia, Manufacturing industries, Learning organizations

Paper type Research paper

Introduction

Technology is recognised as one of the most important factors for remaining competitive in the global business environment. The successful industrialisation of many Asian economies (such as Korea and Taiwan) is attributed to their ability to exploit technological competencies. These countries have evolved from initially acquiring

Journal of Manufacturing Technology Management
Vol. 22 No. 1, 2011
pp. 25-45

1741-038X
DOI 10.1108/17410381111099798

foreign technology to then becoming developers of their own technology. Malaysia as a developing country, currently strives to transform its manufacturing industry into being resilient, broad based and internationally competitive since its economic growth and gross domestic product (GDP) depend largely on this industry. In 2007, the economy expanded by 6.3 per cent owing much to manufacturing as the strongest industrial sector (Abd. Rahman *et al.*, 2009). This phase of industrialisation was accelerated due to technology acquisition strategies during the period.

The challenges facing manufacturing firms in many developing countries include adopting the right technology, using it efficiently and continuously reviewing production processes in order to stay abreast. In addition, another area of interest is the unprecedented surge in strategic alliances formed over the years by firms in developing countries with developed nations (Verspagen and Duysters, 2004). This can be attributed to various cooperative arrangements in the area of technology and knowledge (Hagedoorn, 1996; Duysters and Hagedoorn, 2002). Traditionally, firms have tried to develop technology and knowledge using internal resources, but realised the high costs, time consumption and risks involved. Eventually, these firms resort to strategic technology alliances (STAs) as a method to combine resources and to access up-to-date technologies (Verspagen and Duysters, 2004). There are benefits of such technology collaborations in marketing and sales, knowledge acquisition, profitability, financial and operational performance (Liu and Barar, 2009). While prior research has clearly provided some evidence for the existence of technology alliances, very few studies have espoused the value of how such alliances from an organisational learning perspective can impact technology transfer (TT) and new product development. Two additional aspects comprising absorptive capacity and the learning environment (LE) will be addressed in this study using the Malaysian manufacturing sector.

The recent financial crisis in 2008 significantly affected many countries globally. Despite this economic downturn, the Malaysian economy registered a growth rate of 4.6 per cent in its GDP, supported by domestic demand and continued expansion in private and public consumption. The manufacturing sector significantly contributed to this growth supplemented by the export of manufactured goods (The Malaysian Industrial Development Authority, 2008).

Malaysia has now become leading exporters of computer and electronic products from being the world's largest manufacturer of rubber and tin (Karim *et al.*, 2008). Technological advancement is imperative to reach Malaysia's goal of becoming an industrialised nation by the year 2020. There are increased efforts targeted at improving research and development (R&D) and innovation in the manufacturing industry, and focusing on various sectors such as advanced electronics manufacturing, automated manufacturing, photonics and biotechnology (The Malaysian Industrial Development Authority, 2008). Owing to the strategic importance of technology development in Malaysia, this research examines the impact of absorptive capacity, the LE and the nature and type of alliances on TT and new product development. A theoretical framework has been developed to analyse the results of a survey from manufacturing firms in Malaysia.

Literature review

Organisational learning

Dogsdon (1993) defines organisational learning as the ways firms enhance their knowledge and ability by aligning knowledge around the organisational culture as

well as adapting it within the organisation to increase the efficiency of the workforce. Organisational learning includes R&D, training and formal education of employees. It also involves the means that the organisation uses to disseminate information throughout its employees and how this information is processed and stored.

There is an increase in the number of alliances formed by firms with the objective to adopt new technologies and knowledge. Collaborations are engaged through allocating and sharing resources between partnering firms, universities, private research centres, customers and suppliers (Dogsdon, 1993). They serve as an important platform for organisational learning, knowledge acquisition and for developing new know-hows (Schoenmakers and Duysters, 2006) as well as the effective transfer of tacit knowledge and capabilities (Mowery *et al.*, 1996). However, firms need to attain a certain level of learning ability or absorptive capacity in order to reap the benefits from organisational learning (Zahra and George, 2002), which in turn enable firms to meet current needs of technology and market. Such collaborations facilitate the learning and acquisition of new knowledge either through internal development of new product, services or external technology acquisition (Schoenmakers and Duysters, 2006; Cohen and Levinthal, 1989). Organisations in late-industrialising countries tend to adopt and diffuse technologies from more advanced countries as a means to remain competitive. These firms require skills in technological capabilities mainly through technological learning (Berger and Revilla Diez, 2006). This form of learning often results in technological innovation, operational and efficiency improvements and an increase in reliability and corporate adaptability; which lead to higher levels of organisational capabilities and competitiveness (Gupta and Thomas, 2001; Santa *et al.*, 2009). Conversely, firms with low or stagnant organisational learning face challenges adjusting to environmental changes and ultimately their ability to reduce costs or to change product lines (Kloot, 1996). Based on these arguments, many organisations in developing countries realise the need for new knowledge and technological capabilities, and tend to engage in STAs as a measure. The following sections illustrate three aspects of organisational learning: absorptive capacity; nature and type of STAs (N&T); and LE.

Absorptive capacity

Although the term absorptive capacity is used under a diversity of settings, its definition and operationalisation remain unclear (Lane *et al.*, 2001). Cohen and Levinthal (1990) define absorptive capacity as the level of knowledge overlap between partners; including the ability of a firm to value, assimilate and commercially utilise new, external knowledge. A firm's innovative competencies are associated with its capacity to identify and value new external information while incorporating and applying knowledge for the firm's commercial advantage. Hence, a firm's absorptive capacity is largely related to the firm's level of prior knowledge (Cohen and Levinthal, 1990).

Zahra and Gorge (2002) further reconceptualise absorptive capacity as a set of organisational practices and procedures by which firms acquire, assimilate, transform and exploit external knowledge. For effective learning to take place, partnering firms should have "medium knowledge overlap" (Schoenmakers and Duysters, 2006, p. 260) because knowledge overlap that is too high or too low may hinder successful learning in collaborations. This is in line with other studies on the level of absorptive capacity of partners to ensure successful organisational learning, the ability to embrace new technologies, or new business practices (Cohen and Levinthal, 1990; Szulanski, 1996).

This can be seen as a potential source of competitive advantage for firms through the improvement of operational performance and in seizing market opportunities, engaging in alliances and being able to respond rapidly.

Nature and type of alliances

Alliances assist firms with different skills, knowledge bases and organisational cultures, in creating a unique learning opportunity for the partner firms. The alliance, through which firms gain skills and knowledge, is a powerful source of new knowledge that would otherwise be impossible to obtain alone (Inkpen, 1998). Therefore, this form of knowledge acquisition can be capitalised to enhance each partner's strategy and operations (Inkpen, 1998).

Learning outcomes in alliances depend on the nature and type of alliances (scale and link alliances) and the resulting opportunities (Dussauge *et al.*, 2000). Some examples of scale alliances include joint R&D efforts, joint manufacturing of a product or part of a product. In contrast, link alliances focus on merging the (unique and complementary) capabilities and resources of partners that might lead to greater learning opportunities. Dussauge *et al.* (2000) emphasise how link alliances can offer greater learning opportunities as compared to scale alliances. They highlight an example of customer-supplier relationship where one partner provides access to markets whilst the other manufactures the products. Second, the choice of the type of alliances can enhance or impair learning objectives. Various authors acknowledge greater learning opportunities in joint ventures and equity alliances, as compared to non-equity alliances (Anand and Khanna, 2000; Simonin, 2004; Shenkar and Li, 1999). Their studies depict that firms in equity-based collaborations tend to ensure that they reap effective learning and profitable investments.

Forming equity-based alliances is the most effective way to assist knowledge transfer between partnering firms (Shenkar and Li, 1999), as this type of alliance encourages regular interactions and greater commitment of resources in the collaboration (Uzzi, 1997). Firms have found that equity-alliances increase their patent rates significantly as a result of organisational learning (Mowery *et al.*, 1996). Equity alliances are also expected to provide greater learning opportunities and knowledge acquisition than non-equity alliances (Norman, 2004). There is, however, a challenge for firms to maintain a balance between sufficient open knowledge sharing to maintain alliances, and controlling knowledge flows to avoid unintended leakage of valuable technology (Oxley and Sampson, 2004).

Learning environment

The term "environment" in this study includes alliance networks, relationship between partners (that includes trust), adjusting to the local environment and constraints involved in the alliance. Gulati's (1999) longitudinal study highlights that the inclination of firms to enter alliances is related to their available network resources. The location of firms in the network and also their prior alliance relations are important predictors of the repeated new alliance formation of firms. These factors indicate that the firm's environment will influence the decision whether to form alliances or not. Other aspects include business strategy, resource allocation and employee motivation for learning. Organisations need to acknowledge the combination of environmental factors and how they impact on employee self-actualisation and motivation to learn, which in turn,

contribute to organisational knowledge (Crossan, 1999; Snyder, 1998). Learning starts with encouraging employees to improve organisational performance, through adapting to the work culture and increasing efficiency. This is also known as the "learning curve" effect. Organisational learning as opposed to individual learning occurs when the knowledge is imbedded into the organisation.

Alternatively, Norman's (2004) study contends that organisational learning depends on the trust levels between partners. Findings indicate that the amount of knowledge shared is determined by the learning intent of partners and the level of trust between them. Firms tend to be more protective of their knowledge when partners have high learning intent, however, they will lower their guard with trusted partners. In high-technology product development alliances, partnering firms are reciprocally dependent as resources are contributed by each partner in order for the product development to succeed (Gulati *et al.*, 1994). Mutual information sharing and exchange are vital to complete product designs and adjustments (Osborn *et al.*, 1998). Greater frequency and quality of information exchange can increase the innovativeness and quality of products designed, while lowering the costs of development (Larson, 1992). Such exchanges, however, can create learning opportunities that enable a firm to misuse knowledge from partners resulting in a higher risk of knowledge appropriation in development alliances (Park and Kim, 1997).

On the contrary, partners in high trusting relationships will experience greater learning opportunities as they are more willing to share information and knowledge with each other (Norman, 2004). Hipkin and Bennet (2003) also highlight that technology acquirers in developing countries should utilise their suppliers and networks to reap a full range of benefits from the new technologies. In the context of this research, Malaysia represents a newly industrialising and developing economy that is still unable to draw on its own technological capability. As a result, much of the production technology is imported whilst there are few indigenous sources (The United Nations Industrial Development Organisation, 2005).

Outcomes of technology alliances

There are various challenges in explicitly measuring the success of technology alliances formed by organisations. Some studies consider successful alliances as the prolonged alliance existence, while others measure the alliance performance based on the strategic and competitive position of the firm (Hagedoorn and Schakenraad, 1994; Mitchell and Singh, 1996). It can be established that measuring alliance performance is complex, as collaborations are based on multifaceted objectives (Evans, 2001). Various performance measures have been adopted to assess the outcomes of alliances, where some of these include new product development (Lee, 2007), return on asset and investment (Goerzen, 2007), level of efficiency and learning (Nielsen, 2007), partner satisfaction (Judge and Dooley, 2006), product, market and financial performance (Jones *et al.*, 2000), profitability (Hagedoorn and Schakenraad, 1994) and innovation (Ahuja, 2000).

There are, however, limitations to employing traditional accounting or financial data to measure alliance performance (Geringer and Hebert, 1991; Pansiri, 2005). The problems include difficulties in obtaining information; and how profit figures may not stem solely from the alliance, but from other non-technology-related activities such as efficient management or sales of other products (Geringer and Hebert, 1991). The use of financial measures such as sales growth, profitability or return on assets to evaluate

alliance performance also may not be accurate as these measures do not offer any information on the effectiveness of the alliance formed (Gulati, 1998; Kale *et al.*, 2002).

Owing to demanding and complex production processes, including distribution, marketing and R&D efforts in Malaysian manufacturing, there are various measures and schemes to encourage alliances with world-class corporations and research establishments in order to reap TT, enhanced R&D, technical and engineering capabilities and new product development (The Economic Planning Unit, 2006). Despite the difficulties associated with measuring alliance outcomes, this study evaluates the performance of firms using aspects of TT and new product development based on managers' perceptions.

Technology transfer

The economic growth of a country is largely determined by its technological progress where developing countries aim to fill this development gap by acquiring technology from more advanced countries (Jabbour and Mucchielli, 2007). Many developing countries have relied on TT through foreign direct investment as a primary means of technology acquisition (Letchumanan and Kodama, 2000). TT has been defined as the shared responsibility between the source and destination for ensuring that technology is accepted and at least understood by someone with the knowledge and resources to apply or use the technology (Warookun *et al.*, 2005). The current literature on cross-national TT generally tends to highlight the one-way transfer of technology from developed nations to developing nations (Mohan and Zhoa, 1990).

However, the organisational learning perspective needs to be recognised as an essential context for the successful application of technology. The main beneficiary of this learning process is the country on the lower technological trajectory. Kristinsson and Rao (2008) advocate that the transfer of technology between two firms in different countries constitutes a learning process between both parties in the alliance. Developing countries are adopting costly programs, such as tax incentives, subsidised industrial infrastructure and duty exemptions, to attract multinational enterprises as TT brings considerable benefits such as management know-how and export marketing access (Garrick and Gertler, 2003). The absence of technological spillovers, however, is generally explained by the lack of absorptive capacity of the local firms (Jabbour and Mucchielli, 2007). Over the years, Malaysia has relied heavily on foreign direct investments from multinational corporations as the primary source of technology (Lee and Tan, 2006). This is to enhance its technological capabilities and competitiveness of local industries.

New product development

There are various benefits of TT demonstrated in the literature – such as long-term economic growth (Blomstrom, 1990), innovative capabilities and performance (Kotabe *et al.*, 2007), enhanced technological capabilities (Kumar *et al.*, 1999), competitive advantage (Liao and Hu, 2007), increased productivity (Liu and Wang, 2003) and development of local industries (Markusen and Venables, 1999). Similarly, new technologies enable firms to develop innovative new products (Iansiti, 1995).

Chakravarthy and Doz (1992) maintain the importance of introducing new technology as critical to the survival of established companies and how many firms will try to build on that technology to develop new products (Christensen and Bower, 1996).

Technological adoption can be used to create new performance-enhancing components across a generation of new products (Taylor, 2010). For instance, Henderson and Clark (1990) illustrate how successful firms integrate new technology with existing technology across several generations of products. Similarly, Iansiti (1998, 2000) examines changes in the level of technological performance across new generations of a firm's products, with performance improvements driven by experimentation and accumulated experience. New product development (NPD) has thus become a key strategic activity in many firms as new products make an increasingly significant contribution to sales and profits (Koufteros *et al.*, 2005). Nevertheless, product development has relatively long timeframes and is considered more volatile, unstructured and is hard to measure and manage. There are four main stages of NPD:

(1) idea generation and conceptual design;

(2) definition and specification;

(3) prototype and development; and

(4) commercialisation (Sun and Wing, 2005).

The time and effort to complete the transfer of new technology and simultaneously manage product development projects can be challenging for many organisations due to the varying conditions and characteristics of each aspect.

Technology development often is problem oriented with fuzzy targets; product development is solution focused and clearer in terms of market segments. Furthermore, the time horizon of technology development tends to be long term with unclear completion points, while product development is more short term with pre-defined deadlines derived from expected market launch (Magnusson and Johansson, 2008, p. 350).

However, there are various authors who maintain the high dependence and inter-relationships between TT and NPD (Clark and Fujimoto, 1991; Mcdermott, 1999). This study specifically focuses on TT and NPD across boundaries via STAs based on the organisational learning perspective (using absorptive capacity, nature and type of alliances and LE).

Hypotheses

Based on the above discussion, it is hypothesised that the three constructs of organisational learning (i.e. absorptive capacity, nature and type of alliances and LE) through STAs will have a positive impact on TT and NPD (Figure 1). Seven hypotheses are proposed as follows.

Effects of organisational learning on TT and NPD

H1. Absorptive capacity (AC) in organisational learning is positively related to TT.

H2. AC in organisational learning is positively related to NPD.

H3. The N&T is positively related to NPD.

H4. The N&T is positively related to TT.

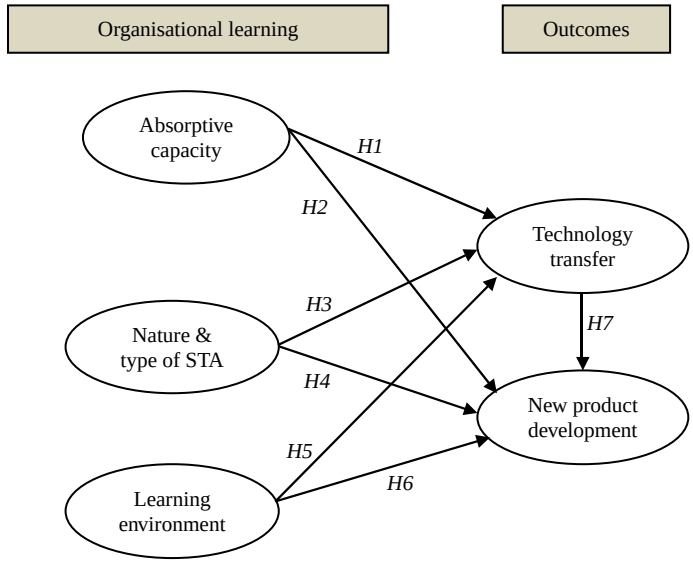


Figure 1.
Proposed model for impact of organisational learning on TT and new product development

H5. The LE is positively related to TT.

H6. The LE is positively related to NPD.

Effects of TT on NPD

H7. TT is positively related to NPD.

Research methodology

Research design

The research was designed to test the hypotheses and gathered data from manufacturing firms in Malaysia. A random sample of 2,500 organisations was selected from a list of 3,717 in the 2008 Federation of Malaysian Manufacturers (FMM) directory. The chief executive officers/managing directors (CEO/MD) or managers were contacted through e-mails, telephone calls and written letters. The target respondent of the survey was the CEO, MD or managers, whose organisation has had some form of STA. The process yielded 569 executives agreeing to participate in the study and emails were subsequently sent to complete an online survey, based on their best performing technology alliance. There were 343 completed surveys during the four month data collection period yielding a 13.8 per cent response rate. Out of these, 335 (13.4 per cent) were found usable for this study. This accounted for 82 small organisations (less than 100 employees), 106 medium-sized organisations (between 101 and 250 employees) and 147 large organisations (more than 250 employees). Respondents originated from various manufacturing sectors in Malaysia as illustrated in Table I.

A non-response bias test was utilised as a comparative tool for early and late respondents to ensure that the responses represent the larger population. The χ^2 tests

indicate no significant difference between both groups of respondents; therefore, non-response bias is not a concern.

Research instrument development – measures

To generate measurement items, exploratory research may utilise several techniques, "including literature searches, experience surveys, and insight stimulating examples" (Churchill, 1979, p. 67). For this study the survey was designed following an extensive review of the literature, with an emphasis on generating a pool of items that reflected the core theoretical constructs. Respondents were required to rate these items based on a seven-point Likert scale ranging from 1 = strongly disagree, to 7 = strongly agree. Once the items were generated, a pilot study was conducted to test the reliability of the instrument and to assess the length as well as the readability of the questionnaire. Two consecutive rounds of pre-testing were conducted in order to ensure that the questions were easily understood by the respondents. A total of 20 managers were randomly selected from the FMM directory and they were contacted and invited to participate in the pilot study via telephone conversations, emails and letters. As a result, four managers agreed to participate in the pilot study. First, the questionnaire was reviewed by three academic researchers experienced in questionnaire design and then piloted with four managers from the manufacturing organisations. This process entailed a follow up face-to-face interview with each manager. The conclusion drawn from the face-to-face interviews was that the questionnaire was too long, and the terms used were "too academic". The final questionnaire was shortened and reworded while retaining its original meaning.

Absorptive capacity

A four-item measure was adapted from various studies to assess the organisation's and its partner's absorptive capacity. Two items were adopted from Lane and Lubatkin (1998) and one item from Simonin (1997) to assess the similarities between partnering firms. The final item was based on Shenkar and Li's (1999) work examining partner selection criteria of organisations based on their willingness to transfer their tacit knowledge.

Nature and type of alliances

Four items were utilised to measure this construct. The item "Our organisation believes that it is important to choose the right type of alliances for effective learning outcomes" was adapted from Dussauge *et al.* (2000). Additionally three items examined the type of alliances (joint venture, equity alliance or non-equity alliance) that might

Manufacturing sectors	Frequency	Percentage
Basic metal product	24	7.1
Electrical and electronics	90	26.9
Electronics and manufacturing services	56	16.7
Engineering supporting	139	41.5
Others	26	7.8
Total	335	100

Table I.
Frequency of respondents by manufacturing sector

result in positive learning outcomes. These items were adopted from Anand and Khanna (2000).

Learning environment

This construct was measured using three items. Two items assessing the LE were adopted from Norman (2004). These items examined learning involving trusted partners. The item "Partner's knowledge protectiveness has a negative impact on knowledge transfer" was adapted from Simonin (1999).

TT and NPD

The outcomes of STAs were measured using two items concerning TT and another two on NPD. Items for TT were adapted from Doz *et al.* (2000) and another from Kotabe *et al.* (2003). These items consider if firms have been able to successfully adopt the new technology and derived any benefit from the TT. In assessing NPD, the item "Our organisation has been able to produce new products or engage in innovation activities" was adopted from Doz *et al.* (2000) and the final item was reworded to suit the context of this study based on Tsang (2002). The measurements utilised in this study are illustrated in Table II.

Analysis and results

First, the items of each construct were assessed using the Cronbach's alpha coefficient and the items-to-total correlation. Table III summarises the coefficient values of the constructs. All constructs have values >0.7 of the cut-off level set for basic research (Nunnally, 1978).

Second, exploratory factor analysis using principal axis factoring as the extraction method and direct oblimin rotation was conducted to assess the underlying structure for the 11 items of organisational learning and the four items of outcomes. This was performed to examine whether the items for a construct share a single underlying factor and if they are uni-dimensional. The Kaiser-Meyer-Oklin (KMO) and Bartlett test of sphericity were performed to test the suitability of running factor analysis. Both results suggested that the matrix was factorable with KMO test value of 0.93 and Bartlett test of sphericity $p < 0.001$. Principal axis factoring identified the presence of three factors with eigenvalues above 1, and the extracted factors account for 62.40 per cent of the total variance. All factor loadings were generally high, where the lowest loading is equal to 0.66 with loadings <0.30 omitted to improve clarity (Leech *et al.*, 2005). The four items measuring performance in the research model were also subjected to principal axis factoring. A two-factor structure was recommended using the criteria of eigenvalue >1 and the extracted factor account for 77.24 per cent of the total variance. All factor loadings were high, with the lowest of 0.83, while KMO test of the factor analysis is 0.81 and Bartlett test of Sphericity $p < 0.001$.

Third, one-factor congeneric models of confirmatory factor analysis (CFA) were conducted to test the validity of the constructs by the number of measured items or indicator variables. Several fit statistics were utilised to evaluate the acceptability of each of the factor models. The overall goal in establishing uni-dimensional measurement models is for each set of indicators to have a unique relationship to the latent variable it represents so that unambiguous meaning can be assigned to each of the constructs (Anderson and Gerbing, 1988). To further support the model,

Construct/item	Source
AC	
Our partner has similar areas of research interests with our firm	Lane and Lubatkin (1998)
Our partner's organisation has a similar organisational structure to our firm	Lane and Lubatkin (1998)
Firms with experience in alliances will achieve higher levels of knowledge in collaborations	Simonin (1997)
Our organisation will select partners that are willing to transfer their tacit or unwritten knowledge	Shenkar and Li (1999)
N&T	
Learning outcomes are higher in joint venture	Anand and Khanna (2000)
Learning outcomes are higher in equity alliance	Anand and Khanna (2000)
Learning outcomes are higher in non-equity alliance	Anand and Khanna (2000)
Our organisation believes that it is important to choose the right type of alliances for effective learning outcomes	Dussauge *et al.* (2000)
LE	
Our organisation learns more from our trusted partners	Norman (2004)
Our organisation shares more information with our trusted partners	Norman (2004)
Partner's knowledge protectiveness has a negative impact on knowledge transfer	Simonin (1999)
TT	
Our organisation has benefited from the transfer of technology from our partners	Kotabe *et al.* (2003)
Our organisation has been able to develop new technology	Doz *et al.* (2000)
NPD	
Our organisation has been able to produce new products or engage in innovation activities	Doz *et al.* (2000)
Our organisation has gained new and additional knowledge	Tsang (2000)

Table II.
Items and measurements for each constructs

Constructs	Number of items	α
AC[a]	4	0.89
N&T[a]	4	0.86
LE[a]	3	0.83
TT[b]	2	0.86
NPD[b]	2	0.85

Notes: [a]Organisational learning constructs; [b]outcomes

Table III.
Measures of construct reliability

the following goodness-of-fit indices (GFIs) are utilised: The GFI was deemed acceptable if above the recommended value of 0.90 (Bentler and Bonnet, 1980), the comparative fit index (CFI) was also used and acceptable at the value of 0.90 or more (Bentler, 1990). Furthermore, adjusted GFI (AGFI), was accepted at 0.90 and root mean square error of approximation (RMSEA) acceptable at the maximum value of 0.08 (Bentler, 1990; Jöreskorg and Sorbom, 1982). Table IV indicates the CFA results of latent variables in this study. Constructs with two or three indicators can be tested

in pairs or with other constructs (Jöreskorg, 1993). Since LE has only three indicators, this construct was tested together with the other two organisational learning constructs and was referred to as "organisational learning" in Table IV. Similarly TT and NPD have only two indicators, therefore, these constructs were analysed together. The results indicated that all scales were uni-dimensional. Given that Mardia's coefficient signifies a value of more than three which suggests the data have a high level of multivariate non-normality (Mardia, 1970), the Bollen-Stine bootstrap p would be a more appropriate statistic for the evaluation of fit for the measurement and full structural models (Bollen and Stine, 1992).

Next, a full measurement model comprising all the constructs of interest was assessed. The data did not fit the measurement model well with $\chi^2 = 185.85$, df = 80, $p \leq 0.001$. However, a bootstrapping procedure was performed resulting in an adjusted χ^2 p value (i.e. Bollen-Stine p) of 0.08, indicating the data fits the model well. Other fit indices include: GFI = 0.93, AGFI = 0.90, CFI = 0.96 and RMSEA = 0.06. Additionally, Fornell and Larckner's (1981) approach was utilised to test the discriminant validity. According to this test, the square root of the variance extracted estimates (AVE) for a given construct should exceed the absolute value of the standardised correlation of the given construct with any other construct in the analysis. Table V indicates the discriminant validity test of all the constructs in this study.

Finally, to test the hypothesised causal relationships among the constructs of the model, structural equation modelling was performed utilising AMOS 17.0. Figure 2 shows the path diagram for the model as well as the estimated standardised parameters for the causal paths, the square multiple correlations and the level of significance of constructs. Using the bootstrapping procedure, the data fit the measurement model well with $\chi^2 = 185.853$, df = 80, Bollen-Stine $p = 0.09$, GFI = 0.93, AGFI = 0.90, CFI = 0.96 and RMSEA = 0.06. The overall analysis results are reported in Table VI.

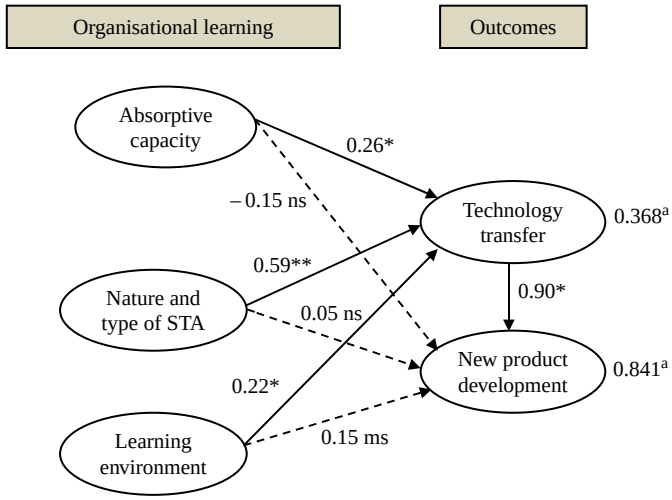
Table IV.
CFA of latent variables

Constructs	χ^2	df	p	Bollen-Stine p	GFI	AGFI	CFI	RMSEA
AC	5.07	2	0.08	0.78	0.99	0.96	1.00	0.07
N&T	6.37	2	0.04	0.68	0.99	0.95	0.99	0.08
Organisational learning	118.82	41	0.16	0.08	0.94	0.90	0.96	0.08
TT	8.48	1	0.00	0.24	0.99	0.90	0.99	0.08
NPD								

Table V.
Discriminant validity test

Constructs	M	SD	LE	N&T	AC	NPD	TT
LE	5.39	1.01	*0.87*				
N&T	5.53	1.07	0.41	*0.86*			
AC	4.97	1.33	0.75	0.60	*0.85*		
NPD	5.76	1.12	0.25	0.60	0.39	*0.92*	
TT	5.76	1.12	0.21	0.65	0.44	0.89	*0.92*

Notes: The numbers in italics in diagonal row are the square root AVE values; M, mean; SD, standard deviation



Notes: Significance at: *0.05 and **0.001; asquared multiple correlation; ms, marginally significant; ns, not significant

Figure 2.
Results of path analysis

Predictor variables	Criterion variables	Hypothesised relationships	Results
AC	TT	*H1*	Supported
N&T	TT	*H3*	Supported
LE	TT	*H5*	Supported
AC	NPD	*H2*	Not supported
N&T	NPD	*H4*	Not supported
LE	NPD	*H6*	Marginally supported
TT	NPD	*H7*	Supported

Table VI.
Hypotheses and results

The findings of this study generally support the conceptual model where a number of the hypotheses were supported.

Table VI summarises the findings where all three organisational learning constructs positively affect TT namely: absorptive capacity (*H1*) $t = 2.322$, $p < 0.05$, N&T (*H3*) $t = 7.371$, $p < 0.001$ and LE (*H5*) $t = 2.350$, $p < 0.05$. This finding supports the literature (Szulanski, 1996; Tidd and Brocklehurst, 1999; Cohen and Levinthal, 1990) where absorptive capacity of partners as well as type of alliances and the LE are important predictors of TT.

Alternatively, the LE shows a marginally positive effect on NPD in these Malaysian manufacturing firms (*H6*) $t = 1.904$, $p = 0.057$. This result reinforces the literature on conducive LEs influencing innovative NPD (Carneiro, 2000; Soo *et al.*, 1999). However, the absorptive capacity (*H2*) $t = -1.628$, $p > 0.05$ and nature and type of alliances (*H4*) $t = 0.648$, $p > 0.05$ are insignificant to NPD specifically in these firms. These relationships may be attributed to knowledge dissimilarity when considering NPD, but rather more complementary knowledge when engaging in the alliance (Carneiro, 2000;

Caloghirou *et al.*, 2004). We argue that by international standards, Malaysian manufacturing firms have limited infrastructure, resource capacities and investments for R&D; let alone production capabilities and technological advantage (Lado and Vozikis, 1996; Tepstra and David, 1985). Much of the development work and strategic initiatives are focused on improving efficiency or quality of production processes, rather than the development of new products. The results may be interpreted by the fact that these organisations could be operating in turbulent conditions, with the outlook of national priorities and consequently embark on STAs mainly for the acquisition of technology as the primary objective. While STAs offer the best way of developing indigenous expertise, Malaysia lacks the social capital (absorptive capacity) and ability to exploit such opportunities (nature and type of alliances) with foreign firms (Tidd and Brocklehurst, 1999).

Nevertheless, *H7* is supported in that TT can have a positive effect on NPD $t = 12.213, p < 0.001$. This relationship as previously established by Iansiti (1995) and Magnusson and Johansson (2008) expound the spillover effects of TT as a result of organisational learning in alliances. According to Nobelius (2004) technology development activities tend to be "late", and firms need to stage-manage "windows of opportunities" for a timely transfer to commercial product development. His study concludes that a variety of information channels and resource planning have to be organised in the TT process. In relation to this study, there is an increasing need for manufacturing firms in Malaysia to focus on resources and activities at the planning stage prior to alliance formation in order to reap technological benefits for developing new products simultaneously. Currently, they are engaging in NPD as a result of TT.

Discussion

Technology alliances can be regarded as an effective mechanism to create competitive advantage for Malaysian manufacturing firms by internalising and adapting technology skills and capabilities. Although transferring knowledge can seem difficult, the formation of alliances will facilitate learning by providing the expectation of a stable, long-term relationship which allows trust and knowledge sharing to develop over time. Our results demonstrate how the nature and type of alliance can enable successful TT. Additionally, absorptive capacity plays an important role. Before organisations can use its newly acquired technology for commercial purposes, they must be able to understand it first – as the acquisition in itself does not lead to such mastery and enable innovative new products. Understanding and assimilating complex technologies requires the active engagement of both parties as well as certain structural and cognitive preconditions (Lane *et al.*, 2001). Collaborations should be seen as opportunities to create, store and apply knowledge. Consequently, managers have to consider how to manage such partnerships to enhance their capabilities and performance. This form of learning, according to Huber (1991) adds to the organisation's knowledge base by internalising knowledge not previously available to it. Second, inter-organisational trust is a critical aspect of absorptive capacity and functions as an ongoing social control mechanism and risk reduction device (Gulati, 1995). Furthermore, as managers seek to incorporate new production methods, there must be a willingness to risk vulnerability and confidence of forbearance among partners. The organisation's capacity to learn is not absolute but rather varies with the learning context and environment. There are factors likely to influence the firm's

absorptive capacity – whether it is familiar with the new technology, whether there is cultural compatibility and whether they have similar operational priorities, business objectives and strategic resources.

Our findings suggest that in the area of NPD, there may be little incentives or skills present in Malaysian firms to undertake innovative approaches. Despite the fact that the manufacturing industry is still in its growth stage, where most organisations are early adopters of innovation and technology, managers should realise the prospects of product differentiation through new technologies where they can present innovative new products, as well as add new functionality and improved performance to existing products. One strategy is to adopt lean approaches with less complexity in product design and production methods, such that their technology readiness can be managed with lower risks. Another approach is to ensure that the technology transferred has reached a feasibility point conducive for full-scale prototypes or models for pre-commercial verification. Since the Malaysian manufacturing industry significantly determines the national economic performance, the early initiation of innovative new products should be embraced by firms as an integrative effort between technology development and product development.

Additionally, this study offers valuable insights to government institutions and policy makers in offering incentives to increase the number of local sales and support offices for manufacturing technologies. These offices can assist and advise local firms in the areas of various technology platforms, feasibility studies, international benchmarking data and product and industry analyses. There are also opportunities for additional public investment and industry support by increasing the number of programs and incentives such as rebates, tax relief and technology grants, for Malaysian firms to enhance their technological competencies. There is, however, a risk that the public investment could be unfruitful, as this research has demonstrated that there are insufficient capabilities present in Malaysian manufacturing firms for developing new products. Therefore, appropriate research is essential to better understand what the key performance objectives are that Malaysian organisations should focus on to improve their absorptive capacity and LE.

TT should lead to NPD for manufacturing firms to gain a competitive advantage, as competition among countries to attract the R&D activities of multinational enterprises has increased substantially during the last few years. But the strategies deployed by government departments in this context still remain largely unexplored (Guimon, 2009). In conclusion, the empirical results for organisational learning as an antecedent of TT and NPD can be engaged by various sectors in the manufacturing industry not only to enhance their strategy formulation and performance outcomes, but also by government institutions to enable the nation to pursue technological capabilities, collaborative R&D, infrastructure investment, capacity building and competitiveness of the country as a whole.

Limitations and further research

The findings presented in this study must be understood in the context of the following limitations: first, it was difficult to identify organisations which had some form of technology alliances before distributing the questionnaire; otherwise a more effective sampling technique such as stratified random sampling would have been adopted. Second, respondents who participated in the survey were required to consider their

best alliance partner in order to evaluate organisational learning and outcomes. Therefore, these analyses and results should be understood as applied to successful alliances that may not necessarily have resulted in TT and NPD simultaneously. It is also important that alliance relationships should be mutual and non-competitive compared to legal contracts. This will ensure that the relationship is capitalised without any restrictions from partners. The results cannot be generalised to the larger population. Nonetheless, this study provides additional insight into the initiatives, strategies and outcomes of manufacturing firms who have embarked on STAs. Since this research is focused on Malaysia, it provides scope for further investigation in other contexts – for example two-way learning between alliance partners in developing and developed countries to determine if there are significant differences among the countries as well as evaluating other effects of learning in STAs such as local culture or government regulation. It is also valuable for future comparative research to examine other possible moderating effects of learning in STAs.

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